



CANDIDATE – PLEASE NOTE!

PRINT your name on the line below and return this booklet with your answer sheet. Failure to do so may result in disqualification.

TEST CODE **02238010**

FORM TP 2017293

MAY/JUNE 2017

**CARIBBEAN EXAMINATIONS COUNCIL
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®
PHYSICS**

Unit 2 – Paper 01

1 hour 30 minutes

05 JUNE 2017 (p.m.)

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 minutes to answer them.
2. In addition to this test booklet, you should have an answer sheet.
3. Do not be concerned that the answer sheet provides spaces for more answers than there are items in this test.
4. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.
5. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

Kirchoff's first law for electric currents can be derived by using the conservation of

- (A) energy
- (B) current
- (C) charge
- (D) power

Sample Answer



The correct answer to this item is “charge”, so (C) has been shaded.

6. If you want to change your answer, erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.
8. You may do any rough work in this booklet.
9. Figures are not necessarily drawn to scale.
10. You may use a silent, non-programmable calculator to answer items.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.



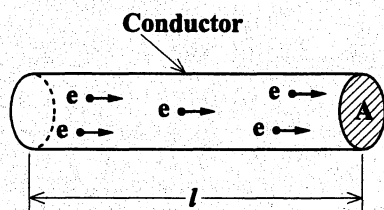
LIST OF PHYSICAL CONSTANTS

Speed of light in free space	c	$=$	$3.00 \times 10^8 \text{ m s}^{-1}$
Permeability of free space	μ_0	$=$	$4\pi \times 10^{-7} \text{ H m}^{-1}$
Permittivity of free space	ϵ_0	$=$	$8.85 \times 10^{-12} \text{ F m}^{-1}$
	$\frac{1}{4\pi\epsilon_0}$	$=$	$9.0 \times 10^9 \text{ m F}^{-1}$
Elementary charge	e	$=$	$1.60 \times 10^{-19} \text{ C}$
Planck's constant	h	$=$	$6.63 \times 10^{-34} \text{ J s}$
Unified atomic mass constant	u	$=$	$1.66 \times 10^{-27} \text{ kg (931 MeV)}$
Rest mass of electron	m_e	$=$	$9.11 \times 10^{-31} \text{ kg}$
Rest mass of proton	m_p	$=$	$1.67 \times 10^{-27} \text{ kg}$
Acceleration due to gravity	g	$=$	9.81 m s^{-2}
1 Atmosphere	atm	$=$	$1.00 \times 10^5 \text{ N m}^{-2}$
Avogadro's number	N_A	$=$	$6.02 \times 10^{23} \text{ per mole}$

1. When a potential difference of 2 V is applied across a resistor, 10 J of energy are converted to thermal energy. What charge flows through the resistor?

(A) 0.2 C
(B) 5.0 C
(C) 12.0 C
(D) 20.0 C

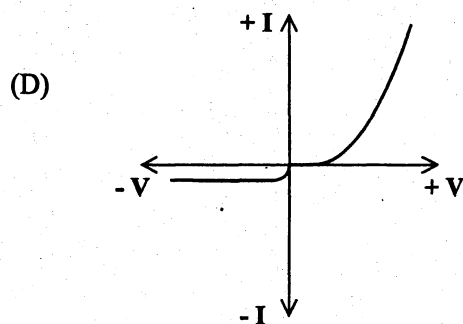
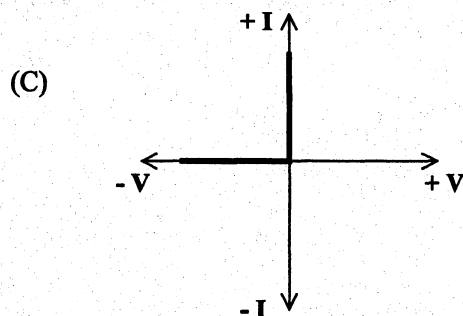
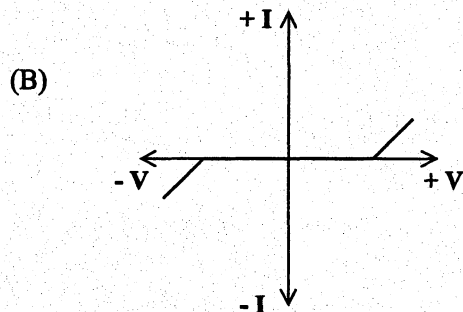
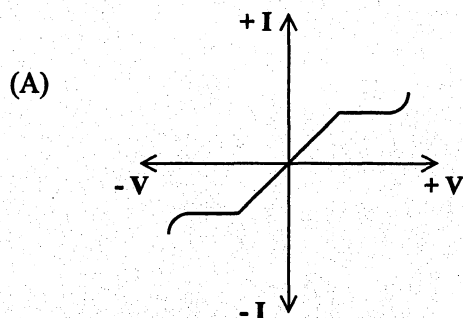
Item 2 refers to the following diagram.



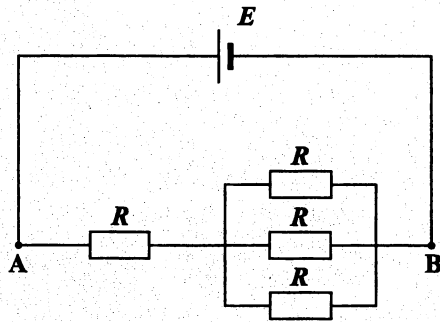
2. The conductor shown above has n free electrons per unit volume, each carrying a charge, e . The electron drift velocity is v . The equation used to calculate the current, I , flowing in the conductor is

(A) $I = n e v A$
(B) $I = n e l A$
(C) $I = n e v A^2$
(D) $I = n e v A l$

3. Which of the following graphs represents the correct relationship between voltage and current for a practical silicon p-n junction diode?



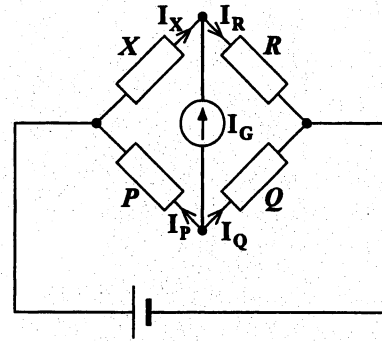
Item 4 refers to the following circuit diagram.



4. If all the resistors have equal resistance, R , what is the effective resistance between AB?

- (A) $\frac{3R}{4}$
- (B) $\frac{4R}{3}$
- (C) $2R$
- (D) $4R$

Item 5 refers to the following circuit diagram which compares an unknown resistance, X , with known resistances, P , Q and R .



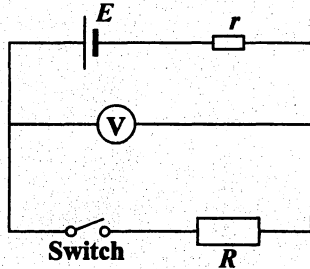
5. If the resistances X , P , Q and R are such that no current flows through the galvanometer, the bridge is said to be balanced.

Which of the following relationships BEST

represents the ratio $\frac{X}{R}$?

- (A) $\frac{1}{PQ}$
- (B) PQ
- (C) $\frac{P}{Q}$
- (D) $\frac{Q}{P}$

Item 6 refers to the following circuit diagram in which a cell of e.m.f., E , and internal resistance, r , is connected to a resistor of resistance, R .



6. A voltmeter of infinite resistance is connected in parallel with the resistor. Which of the following positions for the switch are correct when measuring the e.m.f. and terminal p.d. of the circuit?

	e.m.f.	Terminal p.d.
(A)	Open	Open
(B)	Open	Closed
(C)	Closed	Open
(D)	Closed	Closed

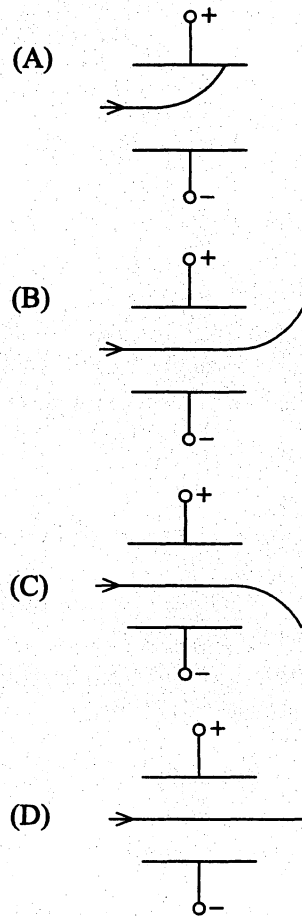
7. What is the electric potential 25 cm from a point charge of $6 \times 10^{-8} \text{ C}$?

- (A) 0.22 kV
(B) 2.2 kV
(C) 22.0 kV
(D) 220.0 kV

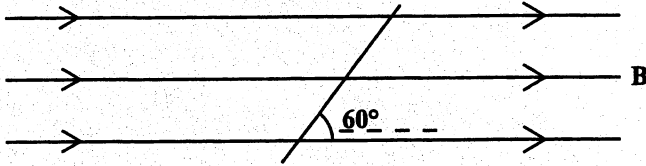
8. The energy stored in a capacitor is given by

- (A) $W = \frac{Q}{C}$
(B) $W = \frac{Q}{2C}$
(C) $W = \frac{C}{2Q^2}$
(D) $W = \frac{Q^2}{2C}$

9. Which of the following diagrams shows the MOST likely path a neutron will follow if the p.d. between two charged plates is increased?



Item 10 refers to the following diagram of a wire of length 30 cm in a magnetic field of strength 3.5 mT, which makes an angle of 60° with the field.



10. If the wire is carrying a current of 2.5 A, what is the magnitude of the force on the wire?

(A) 0.0023 N
(B) 0.13 N
(C) 1.3 N
(D) 2.3 N

11. An ideal transformer has 600 turns in the primary winding and 40 turns in the secondary winding. If the current in the primary winding is 5 A, and the primary voltage is 120 V, what is the current and voltage in the secondary winding?

	Current in Secondary Winding (A)	Voltage in Secondary Winding (V)
(A)	1	15
(B)	8	75
(C)	60	8
(D)	75	8

12. The mathematical equation for the discharge of a capacitor, C , through a resistor, R , is given by

$$Q = Q_0 e^{\left(\frac{-t}{RC}\right)}.$$

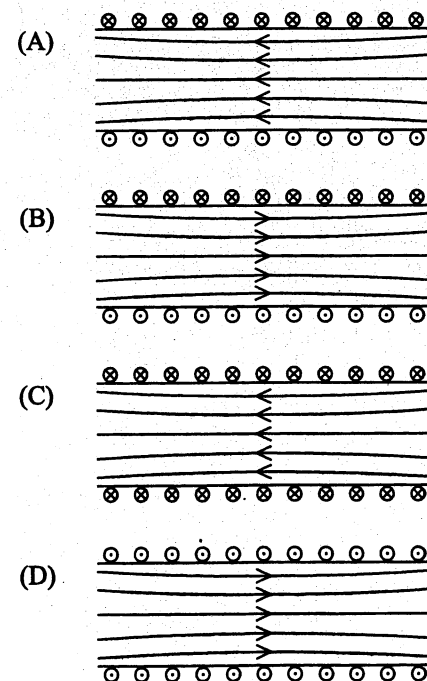
The value of RC is called the

- (A) resistivity of the capacitor
(B) resistance of the capacitor
(C) time constant of the circuit
(D) energy stored before discharge

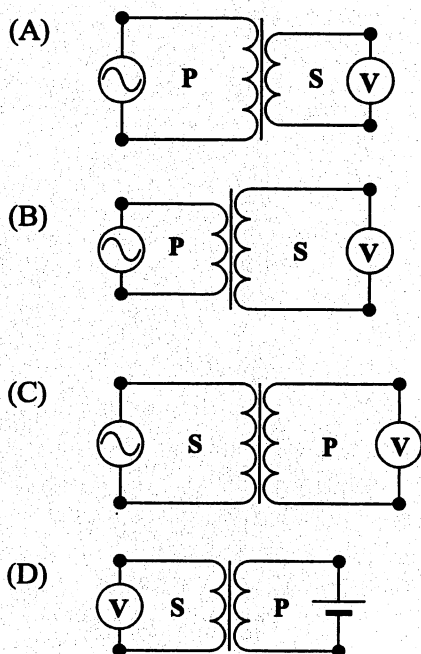
13. A straight wire 1 m long is placed at an angle of 30° in a magnetic field of flux density 0.2 T. It experiences a force of 0.5 N. What is the current in the wire?

(A) 0.5 A
(B) 1.0 A
(C) 2.5 A
(D) 5.0 A

14. Which of the following diagrams BEST illustrates the magnetic flux pattern due to a current in a solenoid?



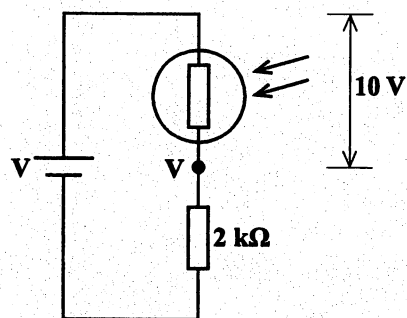
15. Which of the following diagrams represents a step-down transformer?



16. What is the r.m.s value of a sinusoidal signal of peak value 3.0 V?

- (A) 1.50 V
(B) 2.12 V
(C) 4.24 V
(D) 6.00 V

Item 17 refers to the following diagram of a light-dependent resistor (LDR).

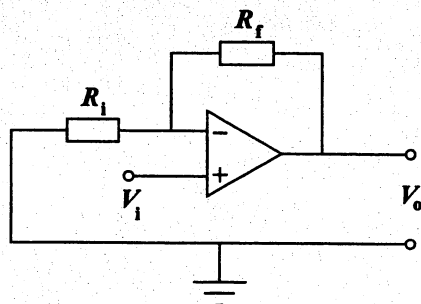


17. With the LDR in complete darkness, the voltage across it is 10 V. When fully illuminated, the voltage across it drops to 3 V. What will be the current in the $2\text{ k}\Omega$ resistor when fully illuminated?

(Assume that when the LDR is in complete darkness, its resistance is infinite.)

- (A) 0.35 mA
(B) 3.5 mA
(C) 5.0 mA
(D) 7.0 mA

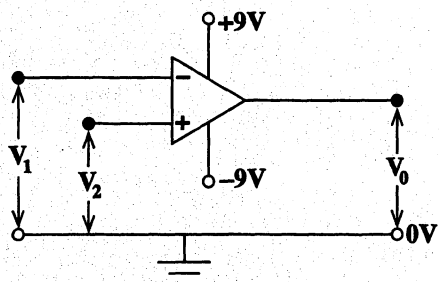
Item 18 refers to the following diagram.



18. The gain of this amplifier is given by

- (A) $\frac{R_f}{R_i}$
(B) $\frac{R_i}{R_f}$
(C) $1 + \frac{R_f}{R_i}$
(D) $1 + \frac{R_i}{R_f}$

Items 19–20 refer to the following op-amp voltage comparator.



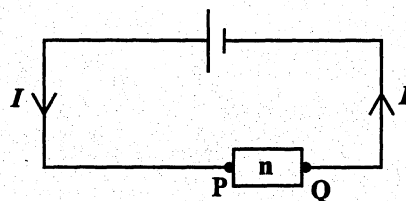
19. The supply voltage to the op-amp is ± 9 V. If the open loop gain is 10^5 , and $V_2 = 0$ what is the maximum input voltage swing, V_1 , for linear amplification?

(A) $\pm 90 \mu\text{V}$
 (B) $\pm 9 \mu\text{V}$
 (C) $\pm 9 \text{ V}$
 (D) $\pm 18 \text{ V}$

20. If the input voltages, V_1 and V_2 , are given as $2 \mu\text{V}$ and $6 \mu\text{V}$ respectively, and the open loop gain is A_0 , what is the value of V_0 ?

(A) $2 A_0 \mu\text{V}$
 (B) $4 A_0 \mu\text{V}$
 (C) $6 A_0 \mu\text{V}$
 (D) $8 A_0 \mu\text{V}$

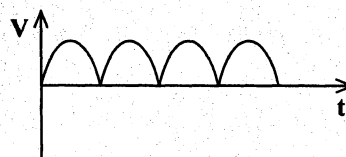
Item 21 refers to the following circuit diagram.



21. In the diagram above, the current, I , flowing through the n-type semiconductor is mainly due to

(A) holes moving from P to Q
 (B) electrons moving from P to Q
 (C) electrons moving from Q to P
 (D) holes moving from P to Q and electrons moving from Q to P

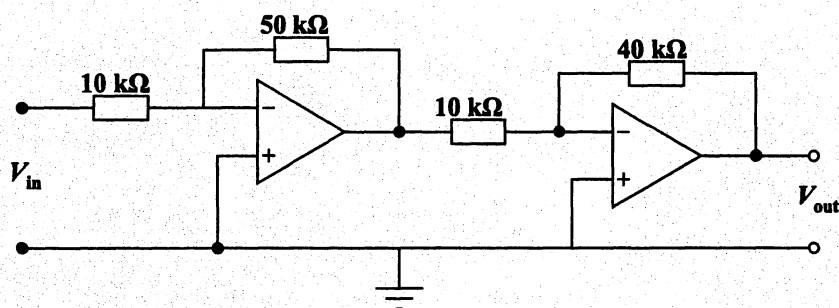
Item 22 refers to the following diagram which shows the output voltage across the load in a bridge rectifier.



22. Which of the following can be done to produce a steadier d.c. voltage across the load shown above?

(A) Place a diode in series with the load
 (B) Place a diode in parallel with the load
 (C) Place a capacitor in series with the load
 (D) Place a capacitor in parallel with the load

Item 23 refers to the following diagram which shows two inverting operational amplifiers connected together.

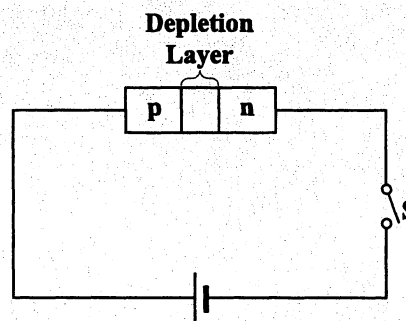


23. Given that $V_{in} = 6 \mu\text{V}$, what is the output, V_{out} , of the cascaded amplifiers?
- (A) $1.2 \times 10^{-4} \text{ V}$
 (B) $5.4 \times 10^{-5} \text{ V}$
 (C) $-2.7 \times 10^{-5} \text{ V}$
 (D) $-1.8 \times 10^{-4} \text{ V}$

24. What is the effect of negative feedback on the gain and bandwidth of an inverting amplifier?

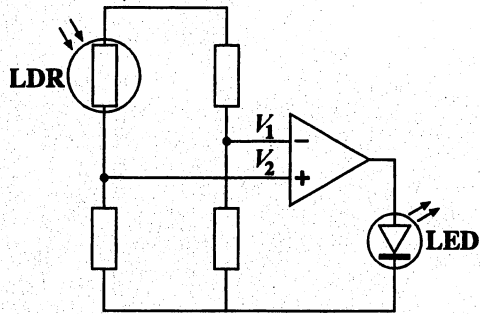
	Gain	Bandwidth
(A)	Decreases	Decreases
(B)	Increases	Decreases
(C)	Decreases	Increases
(D)	Increases	Increases

Item 25 refers to the following diagram.



25. When the switch S is closed, the depletion layer
- (A) widens
 (B) narrows
 (C) disappears
 (D) is unchanged

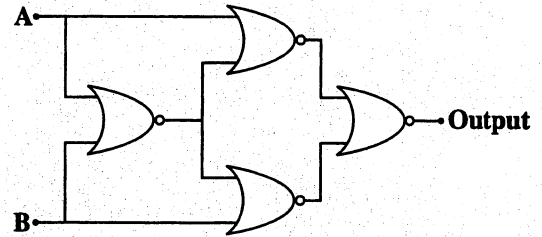
Item 26 refers to the following diagram of an amplifier circuit.



26. In the amplifier circuit shown above, the LED comes on when

- (A) $V_1 = 0$
- (B) $V_1 = V_2$
- (C) $V_1 < V_2$
- (D) $V_1 > V_2$

Item 28 refers to the following diagram which shows a combination of NOR gates.



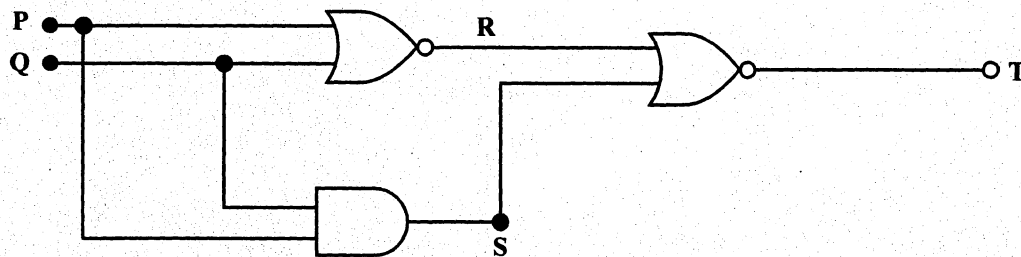
28. Which single gate is the same as this network?

- (A) OR
- (B) NOR
- (C) Ex-OR
- (D) Ex-NOR

27. Which of the following diagrams shows the correct circuit for a half adder?

- (A)
- (B)
- (C)
- (D)

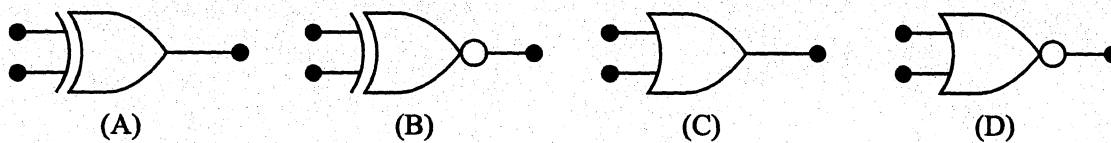
Items 29–30 refer to the following diagram.



29. If the inputs to P and Q are both held at logic 1, then the states of R, S and T are

	R	S	T
(A)	0	1	0
(B)	0	1	1
(C)	1	0	0
(D)	1	1	1

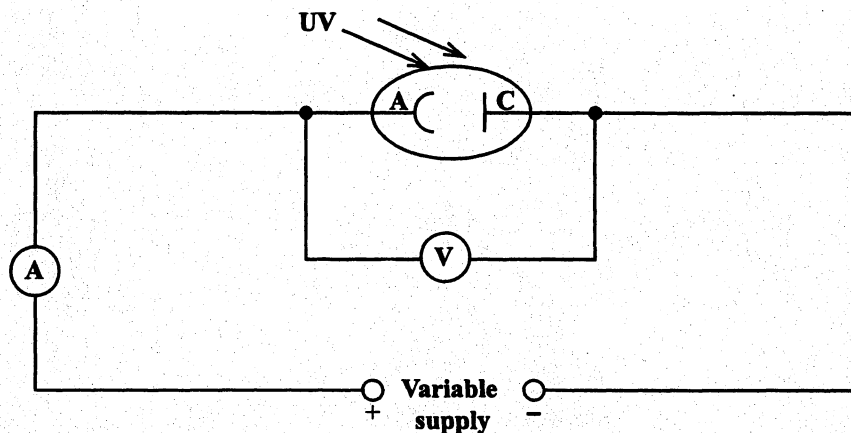
30. The symbol for the logic gate which has the equivalent action to the **complete** circuit above is



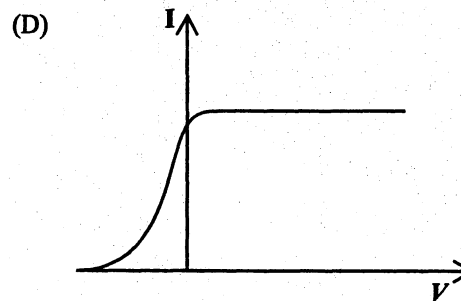
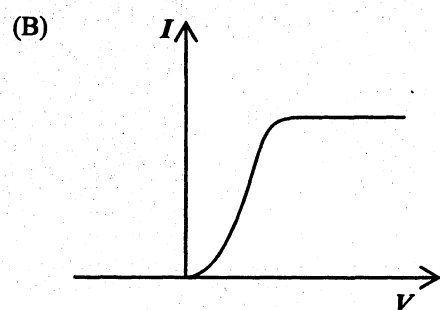
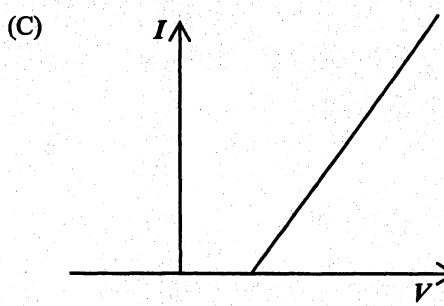
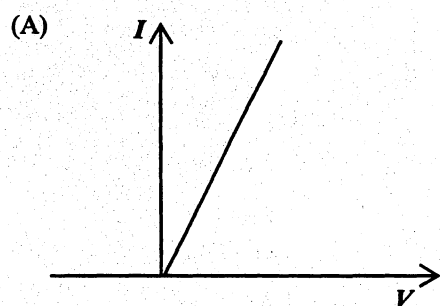
31. Which of the following statements correctly describes the photoelectric effect?

- (A) Emission occurs only if the frequency of the incident radiation is above a certain value.
- (B) As the intensity of the radiation increases so does the kinetic energy of the emitted electrons.
- (C) Emission occurs only after the metal has been ionized.
- (D) The emitted electrons all have the same kinetic energy.

Item 32 refers to the following diagram which shows a photocell, consisting of an anode, A, and a cathode, C, inside an evacuated glass tube, connected to an ammeter, voltmeter and a variable d.c. power supply.



32. When the photocell is illuminated with ultraviolet light and photoelectrons are emitted, corresponding current and voltage values are plotted. Which graph correctly shows the relationship between I and V ?



33. Binding energy is equivalent to the mass
- (A) of the atom
 - (B) of the nucleus
 - (C) difference of the nucleus and its nucleons
 - (D) difference of the nucleus and the atom
34. The equation which represents the radioactive change of a ${}^{60}_{27}\text{Co}$ nucleus by β - emission is
- (A) ${}^{60}_{27}\text{Co} \rightarrow {}^0_2\beta + {}^{60}_{27}\text{Ni}$
 - (B) ${}^{60}_{27}\text{Co} \rightarrow {}^4_2\beta + {}^{60}_{28}\text{Ni}$
 - (C) ${}^{60}_{27}\text{Co} \rightarrow {}^0_{-1}\beta + {}^{60}_{26}\text{Ni}$
 - (D) ${}^{60}_{27}\text{Co} \rightarrow {}^0_{-1}\beta + {}^{60}_{28}\text{Ni}$
35. In Millikan's oil drop experiment, a charged drop of mass 4×10^{-15} kg is suspended between the metal plates by an electric field of strength 4.2×10^4 V m $^{-1}$.
- The charge of the drop is
- (A) 2 e
 - (B) 6 e
 - (C) 9 e
 - (D) 10 e
36. How much energy would be released in a nuclear fission reaction if the mass defect is 0.00687 U?
- (A) 0.02 MeV
 - (B) 1.09 MeV
 - (C) 6.39 MeV
 - (D) 7.04 MeV
37. The photon model shows that the number of photons is proportional to the
- (A) speed of light
 - (B) energy of light
 - (C) energy from heat
 - (D) intensity of light
38. Which of the following scientists suggested that matter had a dual nature and proposed that any particle of a specific momentum had an associated wavelength?
- (A) Planck
 - (B) Germer
 - (C) Davisson
 - (D) De Broglie
39. Electromagnetic radiation is incident on a metal surface whose work function is 6.4×10^{-19} J. The value of the minimum frequency of radiation which will cause electrons to be emitted is
- (A) 3.1×10^{-7} Hz
 - (B) 9.7×10^{14} Hz
 - (C) 6.4×10^{15} Hz
 - (D) 9.6×10^{16} Hz

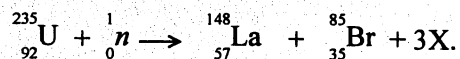
40. Which of the following statements are true about radioactive decay?

- I. It is a random process.
- II. It is a spontaneous process.
- III. It is dependent on the chemical combination of radioactive elements.

- (A) I and II only
- (B) I and III only
- (C) II and III only
- (D) I, II and III

Item 41 refers to the following information.

In a nuclear reactor, Uranium-235 undergoes fission when it collides with a slow neutron. The reaction is given by



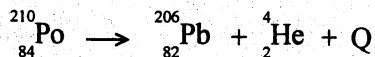
41. What does X in the equation represent?

- (A) Proton
- (B) Electron
- (C) Neutron
- (D) Hydrogen nucleus

42. An electron has kinetic energy of 8×10^{-18} J. What is this value in electron volts?

- (A) 0.5 eV
- (B) 4 eV
- (C) 50 eV
- (D) 80 eV

43. The following equation shows the disintegration of Polonium -210 to a stable isotope of lead:



For the above equation,

the mass of ${}_{82}^{206}\text{Pb} = 205.969$ u

mass of ${}_2^4\text{He} = 4.004$ u

mass of ${}_{84}^{210}\text{Po} = 209.982$ u.

What is the mass equivalent of Q?

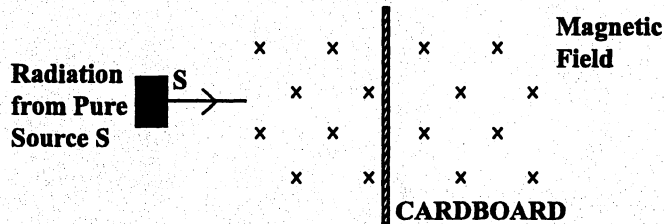
- (A) 1.5×10^{-29} kg
- (B) 6.7×10^{-27} kg
- (C) 3.4×10^{-25} kg
- (D) 3.5×10^{-25} kg

44. What is the half-life for a radioactive isotope containing 10^{20} atoms with a decay constant of $1.60 \times 10^{-5} \text{ s}^{-1}$?

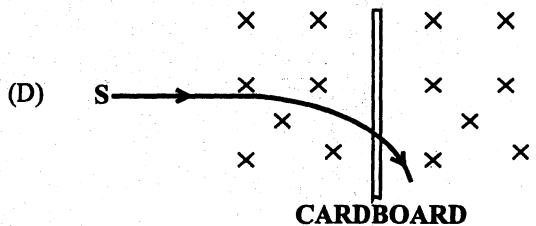
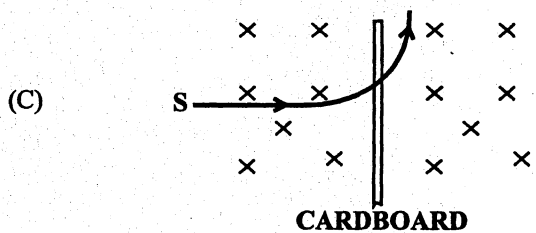
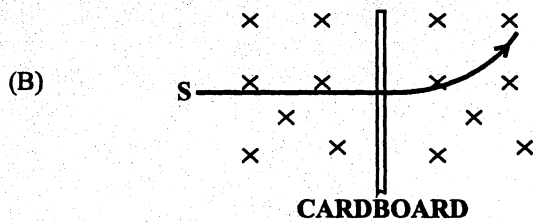
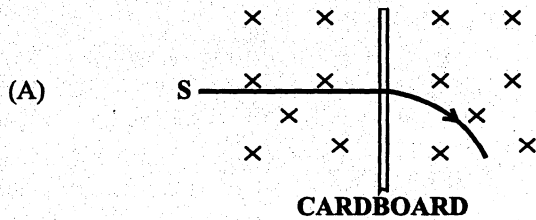
- (A) 1.20×10^{-19} hours
- (B) 4.33×10^{-16} hours
- (C) 12.0×10^0 hours
- (D) 4.33×10^4 hours

Item 45 refers to the following information.

A pure source, S, of a particular type of radiation is placed in front of a thick cardboard sheet in a uniform magnetic field as shown in the diagram.



45. Which of the following diagrams correctly shows the path of the radioactive emission in the region?



END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.